NEW DATA ON PALEARCTIC *APHTHONA* (COLEOPTERA: CHRYSOMELIDAE) WITH DESCRIPTION OF A NEW SPECIES: TAXONOMIC AND FAUNISTIC RESULTS OF BIOLOGICAL CONTROL EXPLORATION[1]

Alexander S. Konstantinov[2], Mark G. Volkovitsh[3], Massimo Cristofaro[4]

ABSTRACT: The results of biological control explorations for *Aphthona* spp. on leafy spurge in Russia are reported. One new species is described based on adults and larvae: *Aphthona russica*, sp. nov. (Russia: Taman' Peninsula). Distributions and host plants of 10 other *Aphthona* species are recorded. *Aphthona gracilis* is reported from Siberia for the first time feeding on *Euphorbia virgata*, and *Euphorbia squamosa* is recorded as a host plant of *A. testaceicornis* for the first time.

The genus *Aphthona* Chevrolat is one of the most speciose flea beetle genera with more than 300 species distributed in the Palearctic, Oriental, Afrotropical and Australian Regions (Konstantinov 1998). A number of *Aphthona* species feed on Euphorbiaceae, especially on *Euphorbia esula* and *E. virgata* (two of the most important noxious weeds in North America). Six Palearctic species of *Aphthona* have already been released in North America as biological control agents of these weeds (White 1996), but additional species are needed to control the weeds in the variety of habitats they have invaded, especially in the forest and mountain areas of the western United States. For the purpose of collecting new, potential biological control agents, field work was conducted in Russia in June and July of 1998. Three major regions were explored: Krasnodar, Novosibirsk and Irkutsk (Fig. 1). The Krasnodar region is located near the Black Sea, northwest of the Caucasus Mountains. The area is heavily cultivated, but some "wild" areas were found close to the seashore and in the mountains. The region includes lowlands (Krasnodar area and Taman' Peninsula) with typical steppe and semidesert vegetation, and Western foothills and low altitude mountains of the Great Caucasus ridge with Caucasian nemoral forest and submediterranean vegetation. The Novosibirsk region is situated in southwestern Siberia with a moderately continental climate. The collecting occurred in relatively small patches of coniferous and deciduous forests (Iskitim Territory), open areas with small birch and aspen

[1] Received June 15, 2000. Accepted July 25, 2000.

[2] Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, MRC 168, Washington, DC 20560-0168, U.S.A.

[3] Zoological Institute, Russian Academy of Sciences, St. Petersburg, RUSSIA.

[4] c/o ENEA Casaccia, INN BIOAG-ECO, via Anguillarese 301, 00060 Rome, ITALY.

woods and wild grasses (forest-steppe), and near several salty lakes (Karasuk Territory). The Irkutsk region (southeastern Siberia) has a unique mountain landscape with mixed forest (taiga) and open spaces (forest-steppe and steppe). The altitude in the area ranged from 300 to more than 2,000 meters above sea level.

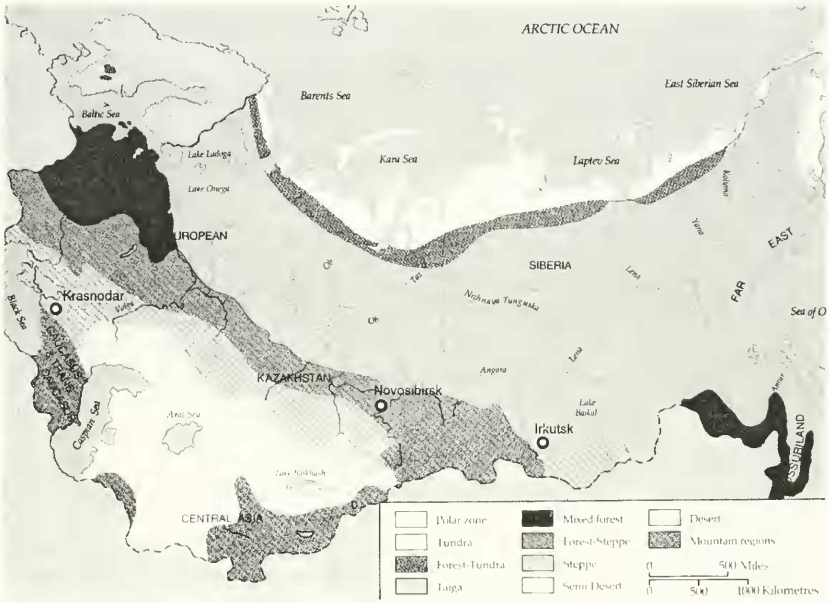


Fig. 1. Map of Russia with collecting locations.

A recently published revision of the Palearctic species of *Aphthona* (Konstantinov 1998) discussed the variability of genitalic structures in *A. lacertosa*. Material collected in 1998 and 1999 provided additional information which led us to the conclusion that *Aphthona* specimens previously identified as *lacertosa* from the Taman' Peninsula are a new species. Study of the biology of this species and preliminary feeding tests conducted in the Laboratory of Systematic Foundation of Biological Control, Zoological Institute, St. Petersburg showed that this species has great potential to become an important agent for control of leafy spurge, especially in wet habitats with heavy clayish soil. During our explorations, new distributional and host plant data for several *Aphthona* species also were collected (Table 1). For adults, we follow the terminology of Konstantinov (1998) and for larvae we use terms proposed by Anderson (1938), Lee et al. (1998), Medvedev and Zaitsev (1978), and Ogloblin and Medvedev (1971).

Aphthona russica, NEW SPECIES

(Figs. 2-4, 7, 11-20)

Description: Adult, female. Body narrow, flat in lateral view. Length 2.60 - 3.85 mm. Width 1.68 - 1.89 mm.

Color black or piceous with light metallic blue luster. Ventral part of body brown. Last 5 antennomeres, dorsal side of metafemur light brown. Rest of legs and basal 6 antennomeres dark yellow.

Head slightly convex in lateral view. Vertex shiny, with fine, sparse punctures. Frontal ridge as wide as antennal callus, widening anteriorly, moderately long, more or less flat, lateral sides parallel between antennal sockets. Antennal calli 1.33 wider than long, moderately convex, contiguous, nearly trapezoidal, forming obtuse angle to each other. Anterofrontal ridge concave, in middle as high as frontal ridge. Supracallinal sulcus slightly curved. Clypeus 3.80 times wider than long. Orbit 0.75 wider than antennal callus. Second antennomere shorter than third and fourth separately, fifth antennomere much longer than fourth and sixth.

Pronotum shiny, flat in lateral view. Base 1.13 wider than apex, almost as wide as elytral base. Lateral margin more or less narrowly explanate. Anterolateral callosity nearly transverse, short, low, with obtuse denticle, straight. Posterolateral callosity poorly developed. Punctures coarse, poorly defined, forming longitudinal wrinkles at base. Basal part of pronotum with denser punctures than apical. Interspaces densely covered with small punctures and wrinkles.

Scutellum wider than long, broadly rounded on top, lateral sides strongly converging. Elytron with poorly developed humeral callus and apical declivity, extremely flat. Lateral sides of elytra almost parallel. Maximum width in middle. Apical margin broadly rounded, straight and obtusely angulate at apex. Punctures coarse, poorly defined, not forming striae on disc, mostly 1.5 - 2 times as large as interspaces.

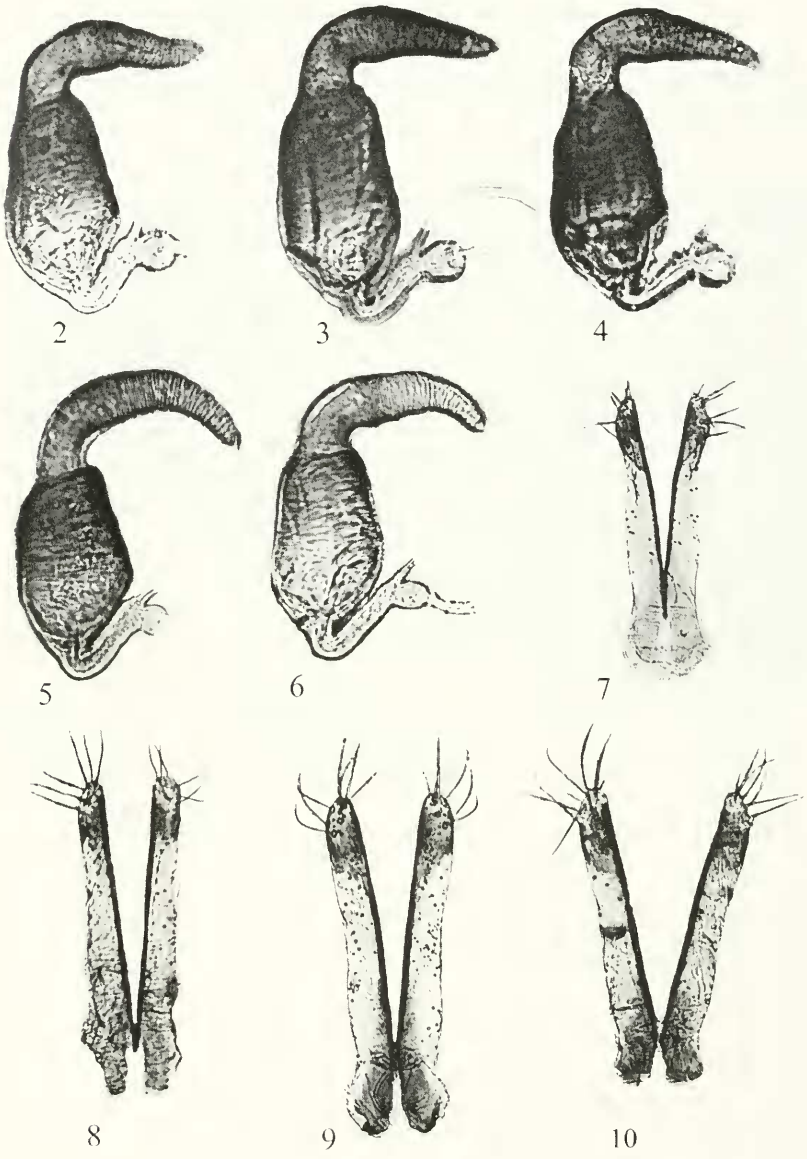
Metatibia slightly curved in lateral view, abruptly widening apically. Flat dorsally at apical 2/3. Medial ridge better developed than lateral ridge. Apex of first metatarsomere slightly wider than base from dorsal view, much narrower than third metatarsomere in female. Second metatarsomere nearly 1.33 times longer than third, 1.25 times shorter than fourth.

Receptacle of spermatheca (Figs. 2-4) 1.20 - 1.25 times longer than pump, apically wider than base of pump. Inner surface slightly more convex than outer surface. Vertical part of pump moderately short, narrower than horizontal part at base. Horizontal part moderately short, usually straight. Duct almost without loop away from receptacle. Anterior sclerotization of tignum slightly curved, normally long, thin in middle, abruptly widening anteriorly. Posterior sclerotization wide, poorly delineated posteriorly. Apical sclerotization of vaginal palpus much shorter than basal. Lateral side of palpus concave before apex.

Male unknown.

Mature larva. Body (Fig. 11) 5.1-7.1 mm long, whitish, subcylindrical, slightly C-shaped, long and slender. All segments elongate, with secondary folds and very sparse, short setae, without distinct tergal sclerite. Head and mandible brown, legs, spiracles, and anal plate apically pale brown to yellowish.

Head 3.5 - 3.9 mm wide, hypognathous, slightly elongated, 1.20-1.25 times as long as wide, almost parallel-sided; moderately sclerotized. Epicranial suture (Fig. 12, EpS) short, endocarina (Fig. 12, Enc) well developed, stronger sclerotized than frons, moderately wide. Frontal suture (Fig. 12, FS) moderately divergent forming 55E angle, nearly straight. Frons (Fig. 12) with three pairs of long frontal setae and two pairs of frontal sensilla. Epicranium (Fig. 12, Ep) with seven pairs of long epicranial setae and eight pairs of epicranial sensilla of which five posterior pairs located by two groups at posterolateral parts of epicranial halves. Ocelli not found. Antenna (Figs. 12, 13) 2-segmented, attached to anterolateral corners of epicranium by articular membrane; antennomere 1 (Fig. 13, A1) moderately sclerotized, bearing large cone-like sensory appendage apically, two campaniform sensilla on lateral sclerite, one trichoid and one campaniform sensilla at base of sensory appendage. Antennomere 2 (Fig. 13,



Figs. 2-10. Female genitalia. 2-6. Spermathecae. 7-10. Vaginal palpi. 2-4, 7 - *Aphthona russica* sp. nov; 5, 6, 8-10 - *A. lacertosa* Rosenhauer.

A2) rudimentary with poorly sclerotized annuliform base, located at anterior part of antennomere 1, bearing large, elongated, cone-like sensory papilla and one seta apically. Clypeus (Figs. 12, 14, Cl) transverse, narrow, covered with angular epistomal projections (Fig. 14, EpP) which bear pair of dipped setae on lateral corners and three pairs of sensilla. Labrum (Figs. 12, 14, Lb) trapezoidal with large, curved, well sclerotized palantine sclerite (Fig. 14, PlS), bearing pair of setae and pair of campaniform sensilla medially, pair of long setae laterally, and two groups of two normal and three flattened, curved epipharingeal setae on anterolateral corners. Mandible (Figs. 15, 16) palmate, well sclerotized, with four long and one small teeth, two mandibular setae externally, and well developed penicillus (Fig. 16, Pe). Penicillus consisting of one thick curved papilla and six or seven long wavy cilia. Cardo (Fig. 17, Cd) narrow, attached to base of stipes, strongly sclerotized and bearing one seta on external margin. Stipes (Fig. 17, St) slightly sclerotized with much stronger sclerotized long anterior projection reaching mala; two setae and one campaniform sensilla present externally. Maxillary palpus (Fig. 17, Plp) 3-segmented, located on palpifer (Fig. 17, Pgr) with hemi-circular narrow basal sclerite bearing two setae (on Fig. 17 the left palpifer with only one seta, which could be a result of reduction that frequently occurs in coleopterous larvae). First and second maxillary palpomeres with narrow, annuliform, sclerotized bases. First palpomere with two campaniform sensilla, second palpomere with one seta. Third palpomere elongate, with one seta and indistinct structure (probably sensory papilla) externally. Mala (Fig. 17, Ma) with sclerotized base and external margin, galea bearing one large sensory papilla located on sclerotized base, three basiconic sensilla and two long peg-like sensilla; lacinia with group of six long, peg-like setae. Ligula (Fig. 17, Lg) broadly rounded anteriorly, without microsetae along anterior margin (probably due to damage during dissection), not separated from prementum. Prementum with well sclerotized horseshoe-shaped mental sclerite (Fig. 17, MSc) bearing two short setae at base, that encircles area comprising labial palpi and three pairs of premental sensilla and three pairs of short premental setae. Labial palpus (Fig. 17, Lbp) 2-segmented, poorly sclerotized, with indistinct structure (probably sensilla) externally. Postmentum with two pairs of postmental setae.

Thoracic segments whitish, sclerites transparent. Thoracic setae short, hyaline, hardly visible (according to Medvedev and Zaitsev (1978), the pronotum of *Aphthona* larvae bears eight setae on anterior margin and six on posterior). Mesothoracic spiracle annuliform, situated on epipleuron. Femur (Fig. 18, Fe) stout, with four setae, one campaniform sensilla ventrally, and six setae around apical margin. Tibia (Fig. 18, Ti) elongated, with fringe of five setae on anterior third. Tarsungulus (Fig. 18, Ta) falciform, strongly curved anteriorly, base with seta. Pulvillus (Fig. 18, Pu) round, as long as tarsungulus.

Abdominal segments with secondary folds, intersegmental limits hardly visible (Fig. 11). External sclerites transparent, inconspicuous, setae well visible only on the lateral parts of abdominal segments. Abdomen with eight pairs of abdominal spiracles (Fig. 19), the peritreme circular. Anal plate (Fig. 20) poorly sclerotized, yellowish, with widely rounded posterior margin, without any trace of urogomphi, bearing 12 pairs of long blunt setae including two pairs situated on ventral surface at margins of pygopod (Fig. 20, Py), four pairs positioned along posterior margin, and one pair located at anterolateral part of anal plate. Tenth abdominal segment well developed, with ventrally directed pygopod (Figs. 11, 20, Py).

Type material. Holotype ♀. Russia, Krasnodar reg. Taman' Peninsula, 10 km. E. Taman', 01.VI.1999, leg. Konstantinov, Volkovitsh ♀ Cristofaro (USNM[5]). Paratypes, same data as holotype (8♀ USNM, 3♀ ZMAS[6]); Myshastovskaya, 21.VI.1998 (7♀ USNM, 4♀ ZMAS); 7 km E. Taman', salt lake near Veselovka, 22.VI.1998 (6♀ USNM, 3♀ ZMAS).

Larval material examined. Larvae reared in the laboratory from the eggs laid during July-August 1998 by the beetles collected in June 1998 in the Krasnodar region. Samples were

[5] USNM - National Museum of Natural History, Washington, DC, USA.

[6] ZMAS - Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

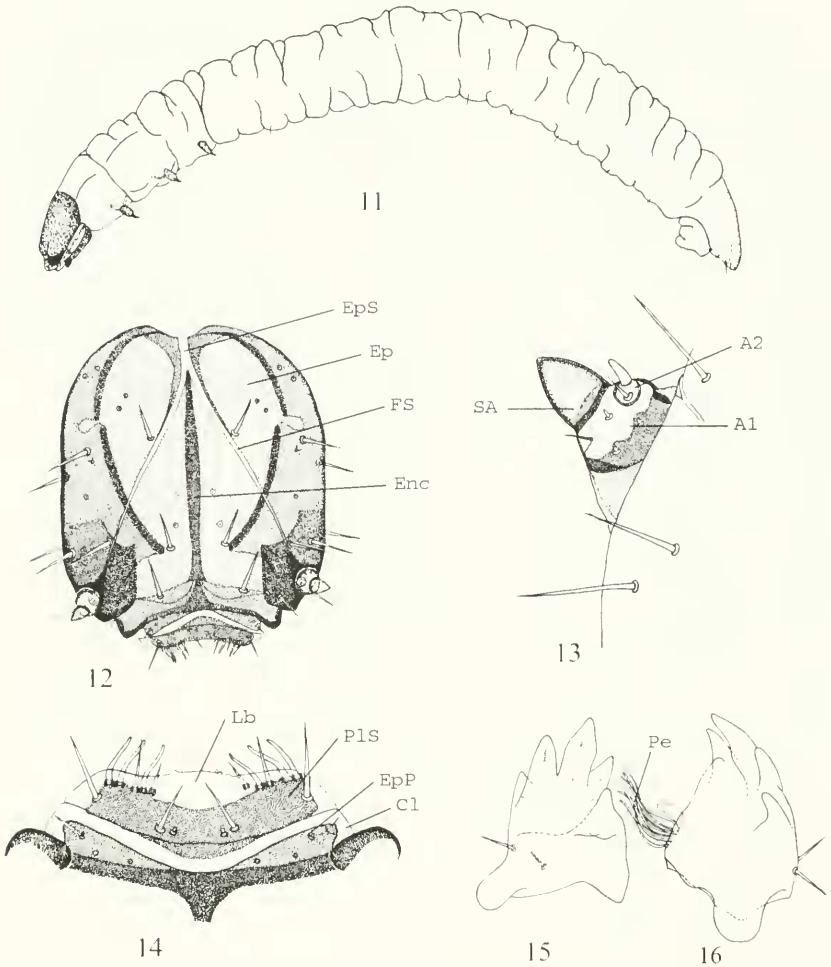
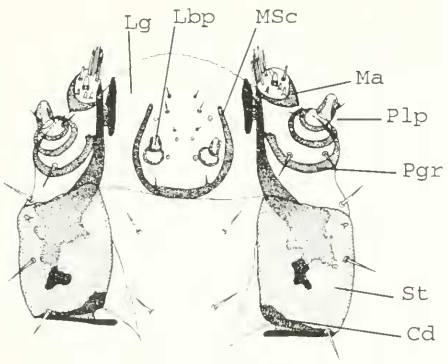
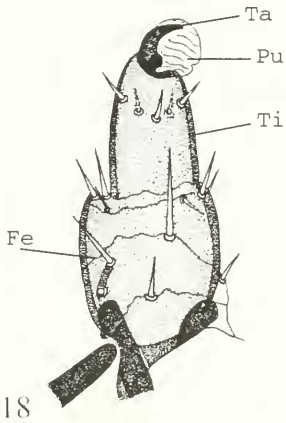


Fig. 11-16. Mature larva. 11- lateral view. 12. Head capsula, dorsal view (mandibles and labiomaxillary complex are removed). 13. Left antenna, dorsal view. 14. Clypeus and labrum, dorsal view. 15. Right mandible, buccal view. 16. Left mandible, ventral view. A1- antennomere 1; A2- antennomere 2; SA - sensory appendage; Cl - clypeus; Enc - endocarina; Ep - epicranium, EpP - epistomal projection; EpS - epicranial suture; FS - frontal suture; Lb - labrum; Pe - penicillus; PlS - palantine sclerite; Py - pygopod.

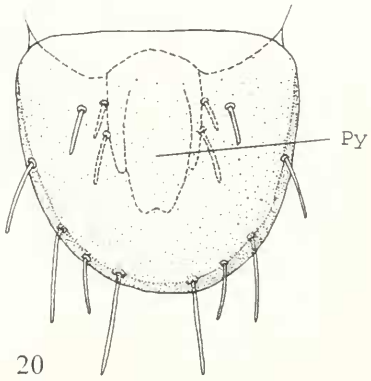


17



18

19



20

Fig. 17-20. Mature larva. 17. Labio-maxillary complex, ventral view. 18. Left hind leg, ventral view. 19. Left 3rd abdominal spiracle. 20. Anal plate, dorsal view. Cd - cardo; Fe - Femur; Lbp - labial palpi; Lg - ligula; Ma - mala; MSc - mental sclerite, Pgr - palpifer; Plp - maxilary palpi; Pu - pulvillus; Py - pygopod; St - stipes; Ta - tarsungulus; Ti - tibia.

taken from soil in potted plants of *Euphorbia esula* on 2 November, 10 December 1998, and 3 January 1999 (10 ZMAS, 5 USNM).

Comments: In the key to the Palearctic species (Konstantinov 1998) *Aphthona russica* keys out together with *A. lacertosa*. It can be separated from *A. lacertosa* by the following characters: base of pronotum with coarser punctures situated

Table I. Distribution and host plants of *Aphthona* species collected in Russia.

Aphthona species name	Author	Locality	Date	Habitat	Number of specimens	Host plant
abdominalis	(Duftschmidt)	Irkutsk region: env. Bokhan.	07/07/1998	sunny, dry road side	≈ 200	*Euphorbia virgata*
beckeri	Jacobson	Irkutsk region: 20 km NW Irkutsk.	05/07/1998	road side	3	*E. virgata*
franzi	Heikertinger	Novosibirsk region: Road Novosibirsk - Karasuk.	27/06/1998	field/forest border	1	?
gracilis [7] [8]	Faldermann	Novosibirsk region: 20 km N. Novosibirsk,	26/06/1998	field with a few leafy spurge plants	12	*E. virgata*
		Toguchinskii ter.; Iskitim ter. 3 km NW Stepnoe;	02/07/1998		7	*E. virgata*
		Ordynsk ter. 5 km W Rogalevo;	01/07/1998		2	*E. virgata*
		env. Karasuk	30/06/1998		1	*E. virgata*
nigriscutis	Foudras	Novosibirsk reg. Road Novosibirsk - Karasuk.	27-28, 30/06/1998	road side, fields	≈ 200	*E. virgata*
placida	Kutschera	Krasnodar region. Black Sea coast between Utrish and Betta.	23/06/1998	field/forest border	1	?

[7] new distyributional record [8] new host plant record

Aphthona species name	Author	Locality	Date	Habitat	Number of specimens	Host plant
pygmaea	Kutschera	Krasnodar region. Env. Anapa, Black Sea Coast	23, 24/06/1998	field/forest border	60	*Euphorbia*
rugipennis	Ogloblin	Krasnodar reg. Taman' peninsula. Salt lake near Veselovka.	22/06/1998	lake side	15	?
russica	sp. nov.	Krasnodar region: Taman' Peninsula: Myshastovskaya;.	21/06/1998	small valley between sea and road	11	*E. virgata*
		7 km E. Taman' env. Veselovka; 10 km E. Taman'	21/06/1998	lake shore	9	*E. virgata*
			01/06/1999		11	*E. virgata*
testaceicornis 8	Weise	Krasnodar region, Road Dzhubga/Krasnodar. 13 S Mirnoe.	24/06/1998	forest	50	*E. squamosa*
tolli	Ogloblin	Novosibirsk reg. Iskitim ter. 3 km NW Stepnoe.;	02/07/1998	field	40	*E. virgata*
		5 km. W. Rogalevo Irkutsk region, 20 km NW. Irkutsk.	01/07/1998	field	3	*E. virgata.*
			05, 11/07/1998	field/forest border	70	*E.virgata*

close to each other, forming coarse longitudinal wrinkles (in *A. lacertosa*, punctures usually are well separated from each other and do not form wrinkles); receptacle of spermatheca (Fig. 2-4) 1.20 - 1.25 times longer than pump (in *A. lacertosa* receptacle is 1.08 - 1.13 times as long as pump (Figs. 5, 6)), horizontal part of pump moderately short, usually straight (in *A. lacertosa* it is relatively longer, curved). Lateral side of vaginal palpus concave before apex (in *A. lacertosa* this part of palpus is straight).

Notes on *Aphthona* species of potential importance for biological control of leafy spurge

As indicated in Table 1, five other species of *Aphthona* (*A. abdominalis* (Duftschmidt), *A. gracilis* Faldermann, *A. nigriscutis* Foudras, *A. pygmaea* Kutschera, and *A. tolli* Ogloblin) were also collected in large numbers. Field observation showed that they control leafy spurge under natural conditions. *Aphthona abdominalis* and *A. nigriscutis* already have been released in the United States and Canada. The latter species is established in sunny and dry habitats and effectively controls leafy spurge mainly due to the damage produced by beetle larvae and the soil pathogens. The former species is not well established, probably because its biotype originates from Italy which has a mild, Mediterranean climate. Siberian biotypes of these species should be better adapted to the severe climate of the northwestern United States.

ACKNOWLEDGMENTS

The authors are grateful to Neal Spencer (USDA, ARS, Northern Plains Agricultural Research Laboratory, Sidney, MT) and Gaetano Campobasso (USDA, ARS, European Biological Control Laboratory, Rome, Italy) for the idea and efforts in organizing this exploration. We thank Alexander Alexeev (Institute of Chemical Kinetics, Novosibirsk, Russia), Margarita Dolgovskaya (Laboratory of Systematic Foundation of Biological Control, Zoological Institute, St. Petersburg, Russia), Sergey Reznik (Laboratory of Experimental Entomology, Zoological Institute, St. Petersburg, Russia), Victor Shilenkov (Irkutsk State University, Irkutsk, Russia), and Vadim Zaitsev (Zoological Institute, St. Petersburg, Russia) for their help during the exploration. Konstantin Baikov (Central Siberian Botanical Garden, Novosibirsk, Russia) identified *Euphorbia* species. Olesya Moskaleva (St. Petersburg State University) inked figures of the beetle larva.

We also thank Javier Blanco (Department of Entomology, Smithsonian Institution, Washington, DC), and Allen L. Norrbom and F. Christian Thompson (USDA, ARS, Systematic Entomology Laboratory, Washington, DC) for their comments on the earlier versions of the manuscript. This study was partly funded by Grant No. 98-04-49763 from the Russian Foundation for Basic Research.

LITERATURE CITED

Anderson, W. H. 1938. Description of the larvae of *Chaetocnema denticulata* (Illiger) and *Chaetocnema pulicaria* Melsheimer (Coleoptera, Chrysomelidae). Proceedings of the Entomol Soc Wash 40:161-169.

Konstantinov, A. S. 1998. Revision of the Palearctic species of *Aphthona* Chevrolat and cladistic classification of the Aphthonini (Coleoptera: Chrysomelidae: Alticinae). Mem Entomol Int. 11, 429 pp.

Jong Eun Lee, S. W. Lingafelter, and A. S. Konstantinov. 1998. Larval morphology of *Systena blanda* Melsheimer (Coleoptera, Chrysomelidae: Alticinae). Proc Entomol Soc Wash 100: 484-488.

Medvedev, L. N. and Yu. M. Zaitsev. 1978. The Larvae of the Leaf Beetles of the Siberia and Far East. Isdatelstvo Nauka, Moskva. 183 pp (In Russian).

Ogloblin, D. A. and L. N. Medvedev. 1971. The Larvae of the Leaf Beetles (Coleoptera, Chrysomelidae) of the European Part of the USSR. Isdatelstvo Nauka, Opredeliteli po faune SSSR, Leningrad. 124 pp (In Russian).

White, R. 1996. Leaf beetles as biological control agents against injurious plants in North America. pp. 373-399. In: P. Jolivet & M. Cox (eds.). Chrysomelidae Biology. V 2: Ecological studies. SPB Academic Publishing, Amsterdam, The Netherlands. 465 pp.